

C L A I M S

1. A hydrogen-fueled motor vehicle comprising:
at least one hydrogen-fueled locomotion subsystem; and
at least one refuelable hydrogen generator operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem on demand, said refuelable hydrogen generator comprising:
at least one electrochemical reactor operative to generate said hydrogen fuel from water on demand; and
a refueling subsystem providing at least one of water, electrolyte, hydrogen, a metal containing material and electrical power to said electrochemical reactor.
2. A hydrogen-fueled motor vehicle according to claim 1 and wherein said hydrogen-fueled locomotion subsystem comprises a fuel cell and an electrical motor powered thereby.
3. A hydrogen-fueled motor vehicle according to claim 1 and also comprising a water recycler operative to supply water produced by said locomotion subsystem to said refuelable hydrogen generator.
4. A hydrogen-fueled motor vehicle according to claim 1 and wherein said hydrogen-fueled locomotion subsystem comprises an internal combustion engine.
5. A hydrogen-fueled motor vehicle according to claim 1 and also comprising an operator controlled hydrogen-fuel generation controller which is operative in response to an input from a vehicle operator for determining the quantity of hydrogen generated by said hydrogen generator at a given time.
6. A hydrogen-fueled motor vehicle according to claim 1 and wherein said hydrogen generator comprises at least one hydrophobic cathode comprising at least one of a Teflon coating, layer and binder.

7. A hydrogen-fueled motor vehicle according to claim 6 and wherein said cathode is operative as a hydrogen-generating and as a hydrogen-consuming electrode.

8. A hydrogen-fueled motor vehicle according to claim 1 and wherein said refueling subsystem is operative to recharge at least one refuelable hydrogen generator while at least one other refuelable hydrogen generator is operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem

204/269

9. A hydrogen-fueled motor vehicle according to claim 1 and wherein said electrical power is provided by solar cells.

10. A hydrogen-fueled motor vehicle according to claim 1 and wherein said electric power is provided by regenerative braking.

proven

11. A hydrogen-fueled motor vehicle according to claim 1 and wherein said electric power is provided to said at least electrochemical reactors while at least one another said electrochemical reactors is generating hydrogen.

proven

12. A hydrogen-fueled motor vehicle according to claim 1 and wherein said electrochemical reactor is replaceable.

13. A hydrogen-fueled motor vehicle according to claim 1 and wherein said hydrogen generator comprises at least one anode and wherein said anode is replaceable.

14. A hydrogen-fueled motor vehicle according to claim 13 and wherein said at least one anode comprises at least one of powder, granules and coated particles.

15. A hydrogen-fueled motor vehicle according to claim 1 and wherein said at least one electrochemical reactor comprises a slowly consumable anode and a quickly consumable electrolyte.

16. A hydrogen-fueled motor vehicle according to claim 15 and wherein said

slowly consumed anode comprises at least one of aluminum and aluminum alloy and wherein said electrolyte comprises at least one of an alkaline electrolyte based on potassium hydroxide solution and a halide electrolyte based on aluminum chloride solution.

17. A hydrogen-fueled motor vehicle according to claim 1 and wherein said hydrogen-fueled locomotion system comprises at least one electric motor and at least one fuel cell that provided electric power to said electric motor.

18. A hydrogen-fueled motor vehicle according to claim 1 and wherein said electrochemical reactor is operative to provide hydrogen to hydrogen buffer tank and said hydrogen buffer tank is operative to provide hydrogen to said hydrogen-fueled locomotion system.

19. A hydrogen-fueled motor vehicle according to claim 1 and wherein said electrochemical reactor comprises a water-based fuel comprising:

at least one of:

a salt selected from a group comprising at least one of halides, trihalides, acetates, sulfates, nitrates, borates, acid salts, chromate, stannate, perchlorate and basic salts of Group I metals, ammonium, Group II metals and Group III metals;

a base; and

an acid;

at least one of zinc, iron, aluminum, magnesium, tin, calcium, lithium, sodium, metal hydrides based on nickel, titanium, rare earth metals; and alloys thereof; and

a catalyst based on at least one of a metal and metal oxide belonging to at least one of the platinum metal group and the transition metal group.

20. A hydrogen-fueled motor vehicle according to claim 19 and wherein said catalyst is formed as a coating on at least one rod, said rod is selectively introduceable into said water-based fuel.

21. A hydrogen-fueled motor vehicle according to claim 19 and wherein said water-based fuel comprises zinc and the catalyst comprises an impurity in the zinc, said impurity is a transition metal.
22. A hydrogen-fueled motor vehicle according to claim 19 and wherein said water-based fuel comprises iron and said catalyst comprises an impurity in the iron, said impurity is a transition metal, which is not iron.
23. A hydrogen-fueled motor vehicle according to claim 19 and wherein said water-based fuel comprises a hydroxide of at least one of potassium, sodium lithium and their mixtures in solution in water.
24. A hydrogen-fueled motor vehicle according to claim 19 and wherein said acid comprises at least one of an inorganic acid and an organic acid.
25. A hydrogen-fueled motor vehicle according to claim 19 and wherein said at least one of zinc, iron, aluminum, magnesium, tin, calcium, lithium, sodium, metal hydrides based on at least one of nickel, titanium, rare earth metals as well as alloys thereof is disposed in said water based fuel as at least one of powder, granules and coated particles
26. A hydrogen-fueled motor vehicle according to claim 1 and wherein said electrochemical reactor comprises a container containing at least one anode, a t least one cathode, an electrolyte and a porous separator sheet separating between said anode and said cathode;
a resistance providing element connected between said anode and said cathode and being operative to control the rate of production of hydrogen by said chemical reactor.
27. A hydrogen-fueled motor vehicle according to claim 26 and wherein said resistance providing element is a pulse width modulator.

204
263-2650

28. A hydrogen-fueled motor vehicle according to claim 26 and wherein said electrochemical reactor is controlled by controlling the level of the electrolyte in the container.

29. A hydrogen-fueled motor vehicle according to claim 26 and wherein said anode comprises at least one of zinc, iron and tin in at least one of sheet and plate forms.

30. A hydrogen-fueled motor vehicle according to claim 26 and wherein said anode comprises at least one of cadmium and lead.

31. A hydrogen-fueled motor vehicle according to claim 26 and wherein said anode comprises at least one of zinc, iron, lead, cadmium and tin provided in the form of at least one of pressed powder and paste pressed on an electrically conducting flat support.

32. A hydrogen-fueled motor vehicle according to claim 26 and wherein said cathode comprises at least one of an electrically conducting plate and an electrically conducting mesh supporting a catalyst for hydrogen production, said catalyst comprising at least one of material based on the platinum metal group and the transition metal group.

33. A hydrogen-fueled motor vehicle according to claim 26 and wherein said electrolyte comprises at least one of salts, acids and bases in the form of at least one of absorbed and gel.

34. A hydrogen-fueled motor vehicle according to claim 33 and wherein said base comprises at least one of hydroxides of potassium, sodium, lithium and their mixtures in solution in water.

35. A hydrogen-fueled motor vehicle according to claim 33 and wherein said acid comprises at least one of an inorganic acid and an organic acid such in aqueous

solution.

36. A hydrogen-fueled motor vehicle according to claim 1 and wherein said chemical reactor comprises a container containing at least one anode, at least one cathode, an electrolyte, and water based fuel;

wherein said anode comprises an electrical conductor and is in direct electrical contact with said water based fuel; and

wherein said cathode comprises an electrical conductor and is coated with a catalyst based on at least one of a metal and metal oxide belonging to at least one of the platinum metal group and the transition metal group; and

wherein said electrolyte comprises at least one of:

a salt comprising at least one of halides, trihalides, acetates, sulfates, nitrates, borates, acid salts, chromate, stannate, perchlorate and basic salts of Group I metals, ammonium, Group II metals and Group III metals;

a base comprising at least one of hydroxides of potassium, sodium, lithium and their mixtures; and

an acid preferably comprising at least one of an inorganic and an organic acid;

as well as at least one of zinc, iron, tin, calcium, metal hydrides based on nickel, titanium, rare earth metals and alloys and wherein said water based fuel is disposed in the electrolyte as at least one of powder, granules and coated particles.

37. A hydrogen-fueled motor vehicle comprising:

at least one hydrogen-fueled locomotion subsystem; and

at least one hydrogen generator operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem, said hydrogen generator comprising an electrochemical reactor operative to generate said hydrogen fuel from water on demand; and

a refueling subsystem enabling at least one of water, electrolyte, hydrogen, metal, electrical power and a replacement hydrogen generator to be provided to said vehicle.

38. A hydrogen-fueled motor vehicle according to claim 37 and wherein said hydrogen-fueled locomotion subsystem comprises a fuel cell and an electrical motor powered thereby.

39. A hydrogen-fueled motor vehicle according to claim 37 and also comprising a water recycler operative to supply water produced by said locomotion subsystem to said refuelable hydrogen generator.

40. A hydrogen-fueled motor vehicle according to claim 37 and wherein said hydrogen-fueled locomotion subsystem comprises an internal combustion engine.

41. A hydrogen-fueled motor vehicle according to claim 37 and also comprising an operator controlled hydrogen-fuel generation controller which is operative in response to an input from a vehicle operator for determining the quantity of hydrogen generated by said hydrogen generator at a given time.

42. A hydrogen-fueled motor vehicle according to claim 37 and wherein said hydrogen generator comprises at least one hydrophobic cathode comprising at least one of a Teflon coating, layer and binder.

43. A hydrogen-fueled motor vehicle according to claim 42 and wherein said cathode is operative as a hydrogen-generating and as a hydrogen-consuming electrode.

44. A hydrogen-fueled motor vehicle according to claim 37 and wherein said refueling subsystem is operative to recharge at least one refuelable hydrogen generator while at least one other refuelable hydrogen generator is operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem

45. A hydrogen-fueled motor vehicle according to claim 37 and wherein said electrical power is provided by solar cells.

46. A hydrogen-fueled motor vehicle according to claim 37 and wherein said

electric power is provided by regenerative braking.

47. A hydrogen-fueled motor vehicle according to claim 37 and wherein said electric power is provided to said at least electrochemical reactors while at least one another said electrochemical reactors is generating hydrogen.

48. A hydrogen-fueled motor vehicle according to claim 37 and wherein said electrochemical reactor is replaceable.

49. A hydrogen-fueled motor vehicle according to claim 37 and wherein said hydrogen generator comprises at least one anode and wherein said anode is replaceable.

50. A hydrogen-fueled motor vehicle according to claim 49 and wherein said at least one anode comprises at least one of powder, granules and coated particles.

51. A hydrogen-fueled motor vehicle according to claim 37 and wherein said at least one electrochemical reactor comprises a slowly consumable anode and a quickly consumable electrolyte.

52. A hydrogen-fueled motor vehicle according to claim 51 and wherein said slowly consumed anode comprises at least one of aluminum and aluminum alloy and wherein said electrolyte comprises at least one of an alkaline electrolyte based on potassium hydroxide solution and a halide electrolyte based on aluminum chloride solution.

53. A hydrogen-fueled motor vehicle according to claim 37 and wherein said hydrogen-fueled locomotion system comprises at least one electric motor and at least one fuel cell that provides electric power to said electric motor.

54. A hydrogen-fueled motor vehicle according to claim 53 and wherein said electrochemical reactor is operative to provide electric power to said electric motor.

55. A hydrogen-fueled motor vehicle according to claim 37 and wherein said electrochemical reactor is operative to provide hydrogen to hydrogen buffer tank and said hydrogen buffer tank is operative to provide hydrogen to said hydrogen-fueled locomotion system.

56. A hydrogen-fueled motor vehicle system comprising:
at least one hydrogen-fueled motor vehicle including:
a hydrogen-fueled locomotion subsystem; and
a hydrogen generator operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem, said hydrogen generator comprising an electrochemical reactor operative to generate said hydrogen fuel from water on demand; and
a refueling subsystem enabling at least one of water, electrolyte, hydrogen, metal, electrical power and a replacement hydrogen generator to be provided to said vehicle.

57. A hydrogen-fueled motor vehicle according to claim 56 and wherein said hydrogen-fueled locomotion subsystem comprises a fuel cell and an electrical motor powered thereby.

58. A hydrogen-fueled motor vehicle according to claim 56 and also comprising a water recycler operative to supply water produced by said locomotion subsystem to said refuelable hydrogen generator.

59. A hydrogen-fueled motor vehicle according to claim 56 and wherein said hydrogen-fueled locomotion subsystem comprises an internal combustion engine.

60. A hydrogen-fueled motor vehicle according to claim 56 and also comprising an operator controlled hydrogen-fuel generation controller which is operative in response to an input from a vehicle operator for determining the quantity of hydrogen generated by said hydrogen generator at a given time.

61. A hydrogen-fueled motor vehicle according to claim 56 and wherein said hydrogen generator comprises at least one hydrophobic cathode comprising at least one of a Teflon coating, layer and binder.

62. A hydrogen-fueled motor vehicle according to claim 61 and wherein said cathode is operative as a hydrogen-generating and as a hydrogen-consuming electrode.

63. A hydrogen-fueled motor vehicle according to claim 56 and wherein said refueling subsystem is operative to recharge at least one refuelable hydrogen generator while at least one other refuelable hydrogen generator is operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem

64. A hydrogen-fueled motor vehicle according to claim 56 and wherein said electrochemical reactor is replaceable.

65. A hydrogen-fueled motor vehicle according to claim 56 and wherein said hydrogen generator comprises at least one anode and wherein said anode is replaceable.

66. A hydrogen-fueled motor vehicle according to claim 65 and wherein said at least one anode comprises at least one of powder, granules and coated particles.

67. A hydrogen-fueled motor vehicle according to claim 56 and wherein said at least one electrochemical reactor comprises a slowly consumable anode and a quickly consumable electrolyte.

68. A hydrogen-fueled motor vehicle according to claim 67 and wherein said slowly consumed anode comprises at least one of aluminum and aluminum alloy and wherein said electrolyte comprises at least one of an alkaline electrolyte based on potassium hydroxide solution and a halide electrolyte based on aluminum chloride solution.

69. A hydrogen-fueled motor vehicle according to claim 68 and wherein said

electrochemical reactor is operative to provide electric power to said electric motor.

70. A hydrogen-fueled motor vehicle according to claim 56 and wherein said hydrogen-fueled locomotion system comprises at least one electric motor and at least one fuel cell that provided electric power to said electric motor.

71. A hydrogen-fueled motor vehicle according to claim 70 and wherein said electrochemical reactor is operative to provide electric power to said electric motor.

72. A hydrogen-fueled motor vehicle according to claim 56 and wherein said electrochemical reactor is operative to provide hydrogen to hydrogen buffer tank and said hydrogen buffer tank is operative to provide hydrogen to said hydrogen-fueled locomotion system.

73. A hydrogen-fueled motor vehicle according to claim 56 and wherein said electrical power is provided by solar cells.

74. A hydrogen-fueled motor vehicle according to claim 56 and wherein said electric power is provided by regenerative braking.

75. A hydrogen-fueled motor vehicle according to claim 56 and wherein said electric power is provided to said at least electrochemical reactors while at least one another said electrochemical reactors is generating hydrogen.

76. A method for recharging a hydrogen-fueled motor vehicle comprising
at least one hydrogen-fueled locomotion subsystem; and
at least one refuelable hydrogen generator operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem on demand, said refuelable hydrogen generator comprising an electrochemical reactor operative to generate said hydrogen fuel from water on demand, the method comprising:

supplying at least one of water, electrolyte, hydrogen, a metal containing material and electrical power to said electrochemical reactor.

77. A method for recharging a hydrogen-fueled motor vehicle according to claim 76 and wherein said hydrogen-fueled locomotion subsystem comprises:

a fuel cell, and
an electrical motor powered thereby.

78. A method for recharging a hydrogen-fueled motor vehicle according to claim 76 and also recycling water produced by said locomotion subsystem to said refuelable hydrogen generator.

79. A method for recharging a hydrogen-fueled motor vehicle according to claim 76 and wherein said providing hydrogen-fueled locomotion subsystem comprises providing an internal combustion engine.

80. A method for recharging a hydrogen-fueled motor vehicle according to claim 76 and also controlling the quantity of hydrogen generated by said hydrogen generator at a given time.

81. A method for recharging a hydrogen-fueled motor vehicle according to claim 76 and wherein said electrochemical reactor comprises an anode and a cathode and wherein said supplying comprises:

providing an electrical connection between said anode and said cathode of the hydrogen generator; and

providing hydrogen gas to said cathode.

82. A method for recharging a hydrogen-fueled motor vehicle according to claim 76 and wherein said at least one electrochemical reactor comprises an anode and a cathode and wherein said supplying comprises:

providing an electrical connection between said anode and said cathode of said at least one electrochemical reactor; and

providing hydrogen gas to said cathode of at least one said electrochemical reactor while at least one another electrochemical reactor generates hydrogen.

83. A method for recharging a hydrogen-fueled motor vehicle the method comprising:

providing at least one hydrogen-fueled locomotion subsystem;

providing at least one hydrogen generator operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem, said providing hydrogen generator comprising providing an electrochemical reactor operative to generate said hydrogen fuel from water on demand;

providing a refueling subsystem enabling at least one of water, hydrogen, metal, electrical power and a replacement hydrogen generator to be provided to said vehicle; and

supplying at least one of water, electrolyte, hydrogen, a metal containing material and electrical power from said refueling subsystem to said electrochemical reactor.

84. A method for recharging a hydrogen-fueled motor vehicle according to claim 83 and wherein said providing hydrogen-fueled locomotion subsystem comprises providing a fuel cell and providing an electrical motor powered thereby.

85. A method for recharging a hydrogen-fueled motor vehicle according to claim 83 and also recycling water produced by said locomotion subsystem to said refuelable hydrogen generator.

86. A method for recharging a hydrogen-fueled motor vehicle according to claim 83 and wherein said providing hydrogen-fueled locomotion subsystem comprises providing an internal combustion engine.

87. A method for recharging a hydrogen-fueled motor vehicle according to claim 83 and also controlling the quantity of hydrogen generated by said hydrogen generator at a given time.

88. A method for recharging a hydrogen-fueled motor vehicle according to claim 83 and wherein said electrochemical reactor comprises an anode and a cathode

and wherein said supplying comprises:

providing an electrical connection between said anode and said cathode of the hydrogen generator; and

providing hydrogen gas to said cathode.

89. A method for recharging a hydrogen-fueled motor vehicle according to claim 83 and wherein said at least one electrochemical reactor comprises an anode and a cathode and wherein said supplying comprises:

providing an electrical connection between said anode and said cathode of said at least one electrochemical reactor; and

providing hydrogen gas to said cathode of at least one said electrochemical reactor while at least one another electrochemical reactor generates hydrogen.

90. A method for recharging a hydrogen-fueled motor vehicle system comprising:

providing at least one hydrogen-fueled motor vehicle including at least one hydrogen-fueled locomotion subsystem; and at least one hydrogen generator operative to supply hydrogen fuel to said hydrogen-fueled locomotion subsystem, said hydrogen generator comprising an electrochemical reactor operative to generate said hydrogen fuel from water on demand; and

supplying at least one of water, electrolyte, hydrogen, a metal containing material and electrical power to said electrochemical reactor.

91. A method for recharging a hydrogen-fueled motor vehicle according to claim 90 and wherein said providing hydrogen-fueled locomotion subsystem comprises providing a fuel cell and providing an electrical motor powered thereby.

92. A method for recharging a hydrogen-fueled motor vehicle according to claim 90 and also recycling water produced by said locomotion subsystem to said refuelable hydrogen generator.

93. A method for recharging a hydrogen-fueled motor vehicle according to

claim 90 and wherein said providing hydrogen-fueled locomotion subsystem comprises providing an internal combustion engine.

94. A method for recharging a hydrogen-fueled motor vehicle according to claim 90 and also controlling the quantity of hydrogen generated by said hydrogen generator at a given time.✓

95. A method for recharging a hydrogen-fueled motor vehicle according to claim 90 and wherein said electrochemical reactor comprises an anode and a cathode and wherein said supplying comprises:

providing an electrical connection between said anode and said cathode of the hydrogen generator; and

providing hydrogen gas to said cathode.

96. A method for recharging a hydrogen-fueled motor vehicle according to claim 90 and wherein said at least one electrochemical reactor comprises an anode and a cathode and wherein said supplying comprises:

providing an electrical connection between said anode and said cathode of said at least one electrochemical reactor; and

providing hydrogen gas to said cathode of at least one said electrochemical reactor while at least one another electrochemical reactor generates hydrogen.

97. A method for recharging a hydrogen-fueled motor vehicle comprising providing a chemical reactor comprising a container containing at least one anode, at least one cathode, an electrolyte, and water based fuel;

wherein said anode comprises an electrical conductor and is in direct electrical contact with said water based fuel; and

wherein said cathode comprises an electrical conductor and is coated with a catalyst based on at least one of a metal and metal oxide belonging to at least one of the platinum metal group and the transition metal group; and

wherein electrolyte comprises at least one of:

a salt comprising at least one of halides, trihalides, acetates, sulfates,

Fig 10

nitrates, borates, acid salts, chromate, stannate, perchlorate and basic salts of Group I metals, ammonium, Group II metals and Group III metals;

a base comprising at least one of hydroxides of potassium, sodium, lithium and their mixtures; and

an acid preferably comprising at least one of an inorganic and an organic acid;

as well as at least one of zinc, iron, tin, calcium, metal hydrides based on nickel, titanium, rare earth metals and alloys;

and wherein said water based fuel is disposed in the electrolyte as at least one of powder, granules and coated particles,
the method comprising:

draining depleted water based fuel;

supplying recharged water based fuel; and

supplying said electrolyte.

98. A method for recharging a water based fuel comprising:

providing a DC power supply;

providing an inert cathode connected to a negative terminal of said DC power supply;

providing at least one inert anode connected to a positive terminal said DC power supply;

providing at least one motor operative to rotate a scraper paddle operative to scrape deposited materials off the surface of said cathode;

supplying depleted water based fuel comprising:

at least one of iron, tin, zinc, cadmium, lead, metal hydrides based on nickel, titanium, rare earth metals, and alloys thereof disposed as at least one of powder, granules and coated particles;

supplying electrolyte comprising at least one of:

a salt selected from a group consisting of halides, trihalides, acetates, sulfates, nitrates, borates, acid salts, chromate, stannate, perchlorate and basic salts of Group I metals, ammonium, Group II metals and Group III metals;

a base, comprising hydroxides at least one of potassium, sodium, lithium

and their mixtures; and

an acid preferably comprising at least one of an inorganic and an organic acid;

at least one of solubilizing and dispersing said depleted water based fuel;

applying DC power between said at least one anode and said at least one cathode; and

operating said motor to propel said scraper paddle to scrape the said deposits off the surface of the cathode.

99. A method for recharging a water based fuel comprising
- providing a container filled with said electrolyte; 112
 - providing a chamber formed inside said container
 - providing at least one hydrophobic gas diffusion, hydrogen consuming, cathode, formed as at least one of the walls of said chamber;
 - providing at least one current collector electrically connected to said cathode;
 - providing a porous, electrically insulating separator between said cathode and said anode; 112
 - supplying electrolyte comprising:
 - at least one of:
 - a salt selected from a group consisting of halides, trihalides, acetates, sulfates, nitrates, borates, acid salts, chromate, stannate, perchlorate and basic salts of Group I metals, ammonium, Group II metals and Group III metals;
 - a base comprising at least one of hydroxides of potassium, sodium, lithium and their mixtures thereof; and
 - an acid comprising at least one of an inorganic acid such as sulfuric acid and an organic acid such as citric acid;
 - supplying depleted water based fuel comprising at least one of zinc, iron, tin, cadmium, lead, metal hydrides based on at least one of nickel and titanium and rare earth metals and alloys thereof disposed in said electrolyte as at least one of powder, granules and coated particles;
 - supplying hydrogen gas to said chamber.

205/334